Space Weather Technical Forecast

Issued on Wednesday, 22 February 2023 at 13:57 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares (R1-R2; Minor-Moderate radio blackouts) Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate. AR3234 produced the most significant flare in the past 24 hours reaching M5.1 at 21/2017UTC. Six numbered sunspot regions are on the visible disc. Of particular note in the northeast is AR3234 which continues to grow in areal extent, though now having lost its delta magnetic configuration, the central compact region appears to be splitting. AR3229 in the north centre disk is also of note, with activity from this spot in recent days. The final sunspot worthy of comment is AR3230 in the southeast, this spot has shown some minor growth of its trailing portions. All other spots are small or simple.

Currently no significant Earth-directed CMEs are forecast, although glancing impacts may occur on days 1/2 and 4 (Wednesday/Thursday and Saturday).

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, were indicative of lingering CME influence from the 17 February X2.2-tied event, which arrived at Earth 20/1045UTC. The solar wind has been mostly Slightly Elevated. The solar wind density has been at mostly average levels with a peak reaching 14ppcc at 21/1557UTC. The IMF has been at Moderate levels throughout reaching 12nT at 21/1503UTC. The north-south component, Bz, was mostly positive, with fluctuations between +9 and -8nT (Weak to Moderate). The phi angle was mainly away from the Sun (positive). The net result of the above solar wind measures has been mostly Quiet to Unsettled (Kp 0-3), with a peak of Active (Kp 4) seen in the 12-15UTC period on 21st.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 ranged between Moderate and Normal Background levels, with a diurnal peak of 428pfu at 21/1730UTC. The associated 24-hour electron fluence has been well below the Active (1e8 integrated pfu) threshold, reaching 4.01e6 integrated pfu at 22/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is forecast this guidance period, with the presence of both the X2.2-producing AR3229 and now a new potent and growing region AR3234 in the northeast. Both of these dominant groups should be present throughout the four days.

Solar Wind / Geomagnetic Activity: There are two low confidence CMEs in the forecast - one left the southwest quadrant on 19 February, with a low risk of arriving Wednesday 22 or into Thursday 23 February (UTC). Another glancing blow is possible on Day 4 (Saturday 25 February 2023) from a CME which left the Sun on 21st. The above excepted, Earth will probably experience slightly elevated solar winds before entering a High Speed Stream (HSS) related to CH77's during day one, Wednesday 22 February, and this gives a peak Slight Chance of G1 for the four-day period, reducing with time to largely Quiet conditions by the end of the current UTC

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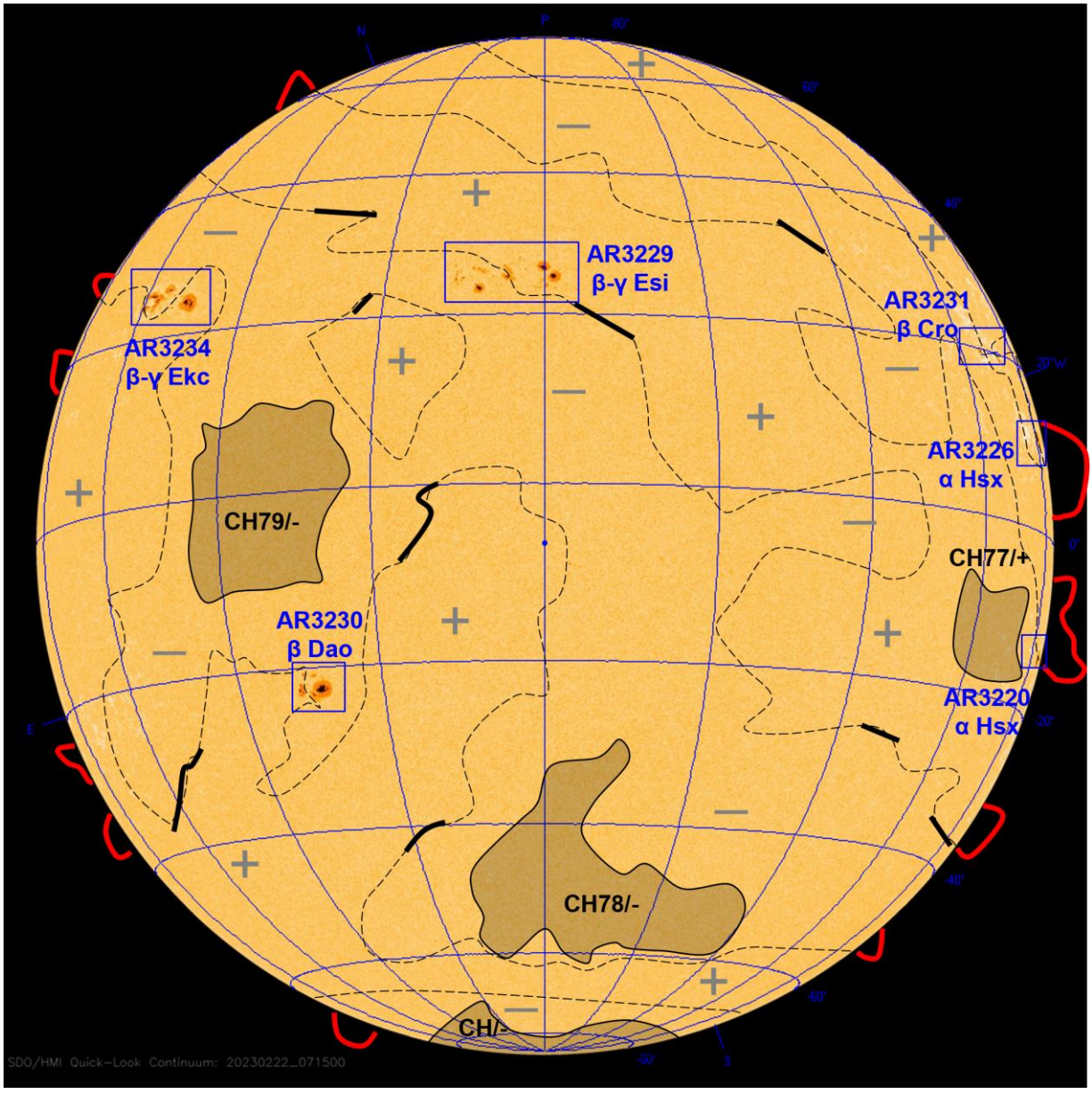
week (with moderate confidence given the possibilities of CME shocks).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at Background levels, but with a slowly increasing Slight Chance of rising towards the S1 level, perhaps exceeding it, should any suitable larger flares occur. High energy (greater than 2 MeV) electron flux may increase later in the forecast period in response to the fast wind enhancement, however this is low confidence. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 22/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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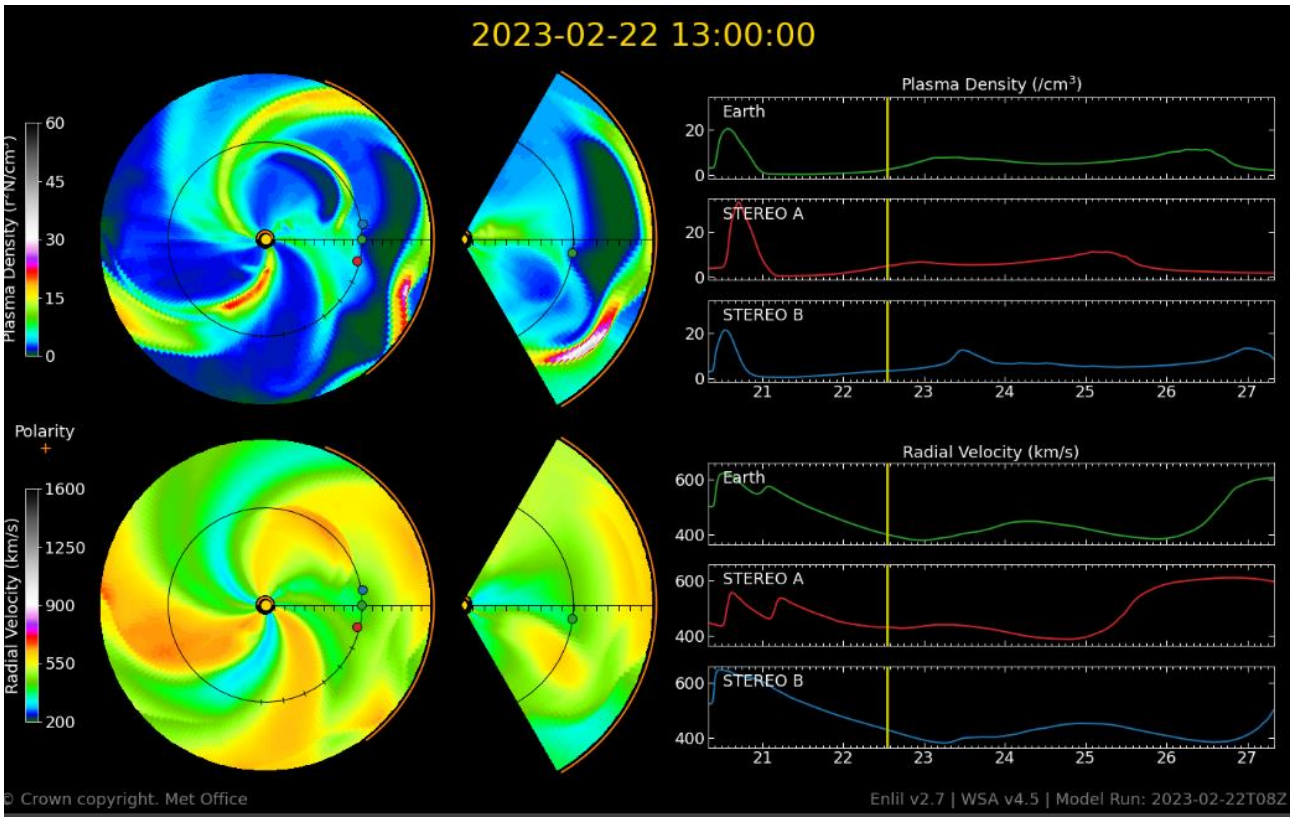
Geomagnetic Storms:

There are two low confidence CMEs in the forecast - one which left the southwest quadrant as a prominence eruption on 19 February, although any influence should be from the shock only and even this is low confidence, passing 1AU later Wednesday 22 or into Thursday 23 February (UTC). A second glancing blow from a CME is possible on day 4 (Saturday 25 February 2023), from a CME that left the sun from the northwest on 21 February, but most of this should pass over Earth. The above excepted, Earth should see a slight elevated regime transition to a HSS one related to CH77's during Wednesday 22 February, perhaps giving a peak Slight Chance of G1 for the four-day period. This should then reduce with time to largely Quiet conditions by the end of the current UTC week (with moderate confidence given the possibilities of CME shocks).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



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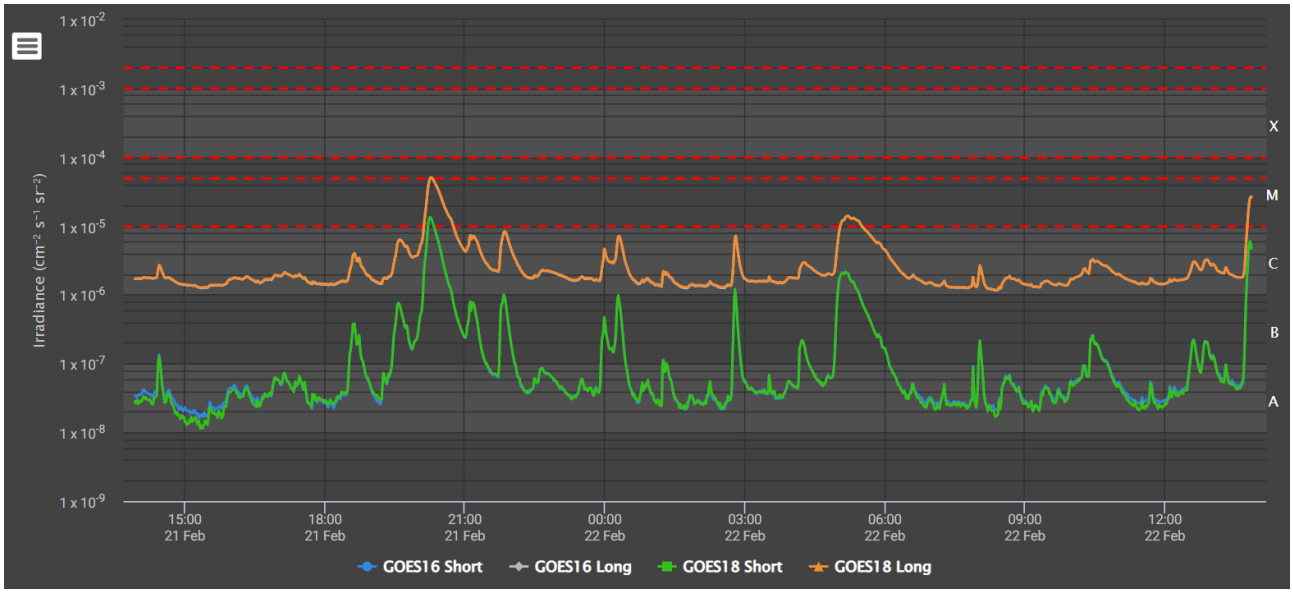
Radio Blackouts - X-Ray Flares:

Solar activity is Moderate with little change likely in coming hours. There remains a daily slight chance of High solar activity resulting from any isolated X-class flare activity, primarily from AR3234, which produced the most significant flare in the past 24 hours reaching M5.1 at 21/2017UTC. Six numbered sunspot regions are on the visible disc. Of particular note in the northeast is AR3234 which continues to grow in areal extent, though now having lost its delta magnetic configuration, the central compact region appears to be splitting. AR3229 in the north centre disk is also of note, with activity from this spot in recent days, though no major changes have happened since the last issue. The final sunspot worthy of comment is AR3230 in the southeast, this spot has shown some minor growth in recent hours of small trailing spots. All other spots are small or simple.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: 24 hour X-Ray Trace



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at Background levels.

While there have been no notable enhancements to the high energy proton spectrum in the past UTC week, this is perhaps largely because the larger X-ray events have been limited to the eastern solar hemisphere. AR3229 and AR3234's westward progress should offer a very gradually increasing Slight Chance of reaching S1 or above as they rotate into a more favourable position should they flare more energetically.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed at GOES16 is currently showing a very slight day-on-day increase to oscillate between Moderate and Normal Background levels.

There are some signals that a high speed stream related to CH77 may have arrived at STEREO A (a day upwind in the Parker spiral), although the speed trace is erratic and has yet to settle, which makes gauging the intensity of CH77 difficult. It is still therefore considered relatively unlikely that CH77 should prove capable of Active electron fluence later this working week (UTC). With remaining transients now low confidence for affecting Earth at all, and with CH77 a persistent feature, confidence in MOSWOC REFM output is increasing, and this persists in maintaining below-Active fluence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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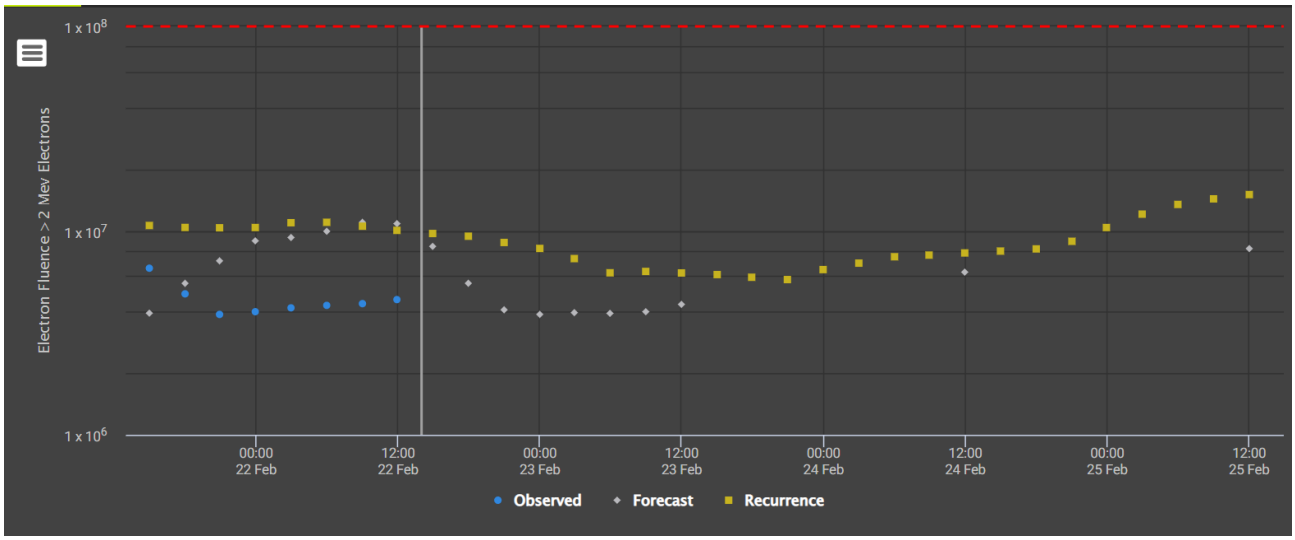
Figure 4: MOSWOC REFM



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